may be necessary. The outer ciliated cells swell up, and are finally cast off. The embryo then becomes an elliptical cyst, the pigmented eye-spots being still preserved, fig. E. The cyst grows and elongates. The body is then covered by an external cuticle, under which is a sparse musculature, followed by an epithelium, which lines the cavity, and forms the greater part of the thickness of the body-walls. The author gives some further structural details. Sometimes, but less frequently than in other species, these sporocysts multiply by transverse division, effected by a gradually deepening constriction about the middle of the body.

The next larval forms, the rediae, are developed within the sporocyst. The cells, which each give rise to a redia, are in part soon present in the embryo; but they increase later by proliferation of the cells lining the cavity of the sporocyst. The first clearly recognized appearance of the rediae is as a morula-like cluster of cells, which soon assumes the gastrula form. An external membrane appears, and, later, a pharynx. There are several germs in each cyst, usually one redia (less frequently two) nearly ready to leave the sporocyst, with two or three germs of medium size, and several small ones, fig. B. When ready to leave the cyst, the redia, by its own motions, makes a forcible exit by rupturing the walls of the sporocyst. The free rediae force their way through the tissues of the host, and are found especially in the liver. They increase in length to 1.3 mm. or 1.6 mm., fig. C; a collar, *q*, being formed, meanwhile, a little behind the pharynx. In other respects, except the possession of a digestive tract, the rediae resemble the sporocysts in structure. They are, however, more muscular, and present other differences, which the author describes. There is present a distinct birth-opening at the side of the body, a little behind the collar, which permits the exit of the brood from within the redia. The germs, *sp*, develop similarly to those of the sporocysts, but are more numerous. Sometimes they form rediae, and sometimes cercariae; yet the early stages of the spores are the same in either case. A germinal cell, forming part of the internal lining of the posterior end of the body-segments, forms a morula. A gastrula enlarges, and gradually assumes a shape that reveals whether it shall become another redia, or a cercaria. There may be as many as twenty-three spores in various stages of development in one redia. It is probably the temperature which determines whether rediae or cercariae are produced; since the former are produced during the warm, the latter during the cold months.

The development of the cercariae, the next form in the series, takes place, as we have seen, in the redia. As the oval enterate spore increases in size, it assumes a more elongated shape; whilst one end becomes more attenuated than the other, and finally is constricted off to form the tail. The thicker portion becomes the body proper, and in it are developed the bifurcate intestine and other organs. Certain cells, F, later develop into the organs for secreting the cyst; and many of the cells in the body of the cercaria are crowded with most remarkable rod-shaped bodies, G, closely resembling bacteria in size and shape, reaching a length of 0.006 mm. In an adult redia, with a brood of twenty or so, there will be one, two, or three cercariae approaching complete development.

As soon as the cercaria has reached the limit of development within the redia, it escapes from the parent by the birth-opening. When free, D, the cercaria is very active, and constantly changes its form. Its most striking characteristic is the presence of the cystogenous cells, D, *c*, before mentioned. These are large, and so crowded with coarse, highly refractile granules as to be rendered quite opaque, F. They are arranged in two-lobed masses, extending along each side of the body, and connected together just in front of the ventral sucker.

By the aid of its suckers, *o* and *s*, and tail, the tadpole-shaped cercaria crawls or wriggles its way out of its host. When the infested snails are kept in an aquarium, the cercariae may occasionally be found swimming about in the water, but not long; for, on coming in contact with the side of the aquarium or the water-plants, it proceeds to encyst itself. The process can be readily observed under the microscope; for, on a glass slide, the cercaria soon comes to rest. It assumes a rounded form; whilst a mucous substance is poured forth all over the body, together with the granules of the cystogenous cells. The tail is shaken off either before or during encystation, which is completed in a few minutes. These cysts are the means of infecting the final vertebrate host of the parasites; the infection being rendered possible by the habits of the intermediate host, Limnaeus truncatulus, which might well be termed amphibious, so strongly is its habit of wandering on land developed. Indeed, they can remain on land for long periods, and resist even prolonged droughts: hence, when in the water, the snails become infested, and, when on land, leave the cercariae that crawl out of their first host scattered over the fields, where they encyst on the grass, and are eaten by the sheep and other animals.

In the stomach the cyst is dissolved, leaving the worm free. The worm then makes its way into the liver, and probably in about six weeks begins to produce eggs, growing meanwhile. During its growth its external form changes, the simple forked intestine develops many coeca, the posterior sucker is greatly enlarged, and the sexual organs are matured. Thereafter, the wondrous cycle of metamorphoses and emigration recommences with the new eggs. There are, perhaps, no other instances more striking, of the adaptation of animal species to particular conditions of existence, than we find in histories of such parasites as the trematode worms, of which we have narrated one life-history. CHARLES S. MINOT.

FLUORINE MINERALS.

P. GROTH has carefully reviewed (*Zeitschr. kryst.*, vii. 457) the following minerals, mostly from Greenland: —

Pachnolite. — This is shown to be entirely distinct from thomsenolite. The pure crystals were submitted to J. Brandl for analysis, who found that they corresponded closely to the formula $NaF \cdot CaF_2 \cdot AlF_3$. It is distinguished from thomsenolite by its absence of water, and has arisen from the analogous mineral cryolite by the substitution of a calcium atom for two atoms of sodium. Heated in the closed tube, the mineral decrepitates violently, covering the sides of the tube with a white powder. The crystals are monoclinic. Almost all show the form of slender prisms, the largest from 2 to 3 mm. long, and 0.5 mm. thick, terminated at one end by an apparently rhombic pyramid, and at the other by two basal planes making a very obtuse angle with one another, showing the twin nature of the crystals. The twinning plane is parallel to the ortho-pinacoid; and the two halves are so equally developed that the two hemi-pyramids appear above like a very perfect rhombic pyramid. The prismatic faces are finely striated in

a horizontal direction. The axial relation $a : b : c =$ 1.1626 : 1 : 1.5320. $\beta = 89° 40'$.

Thomsenolite. — This mineral occurs in far greater quantity than pachnolite. Its chemical composition, from analysis by J. Brandl, is $NaF . CaF_2 . AlF_3 . H_2O$. Heated in the closed tube, it decrepitates violently, giving off acid water. The axial relation $a : b : c = .9959 : 1 : 1.0887$. $\beta = 89° 37\frac{1}{2}'$. Besides the perfect basal cleavage with mother-of-pearl lustre, a second cleavage parallel to the prism was observed. The habit of the crystals is prismatic, the prism striated horizontally.

Ralstonite. — This mineral occurs crystallized in isometric octahedrons; and thus far its constituents have been determined by a qualitative analysis made on a very small quantity, and one imperfect analysis, showing it to be a fluoride of aluminium, magnesium, calcium, and sodium, with water. Carefully selected material, submitted to analysis by J. Brandl, gave the following : F (57.12) . Al (22.14) . Na (5.50) . Ca (1.53) . Mg (3.56) . H_2O (10) = 99.85, corresponding to the formula, $3 (Na_2MgCa) F_2 . 8 AlF_3 . 6 H_2O$. The mineral occurs intimately associated with the thomsenolite.

Chiolite. — This is a tetragonal mineral, resembling cryolite, occurring in the Ilmen Mountains, with axial relation $a : c = 1 : 1.0418$. It seldom occurs in well-developed crystals; and, when so, the crystals are small. Occasionally it is met with in snow-white clusters composed of an aggregate of minute crystals. The various older analyses of the mineral vary very considerably; and a new analysis, by J. Brandl, gives the following result: F (57.30) . Al (17.66) . Na (24.97) = 99.93, corresponding to the formula, $5 NaF . 3 AlF_3$.

Arksutite. — This mineral, which has for a long time been regarded as a distinct species, is shown to be based upon an incorrect analysis, and is probably nothing more than a mixture of cryolite with pachnolite.

Fluellite. — This mineral, which is one of the rarest, is known in the form of minute sharp rhombic pyramids, occurring with wavellite and other minerals from Cornwall. With great trouble .12 gram was obtained quite pure for analysis. This gave J. Brandl the following: F (56.25) . Al (27.62) . Na (0.56) [H_2O (15.55)] = 100. This agrees closely with the simple formula, $AlF_3 . H_2O$.

Prosopit. — This rare mineral, found at Altenberg, Saxony, but not since 1866, occurs mostly altered into kaolin, in some cases the crystals having a core of unaltered material within them, while a few are wholly unaltered. The crystals, while they have been converted into kaolin, have retained their form most perfectly. The crystals are monoclinic, with the axial relation $a : b : c = 1.318 : 1 : 0.5912$. $\beta = 86° 2'$. Pure material gave J. Brandl, upon analysis, F (35.01) . Al (23.37) . Ca (16.19) . Mg (0.11) . Na (0.33) . H_2O (12.41) . loss regarded as oxygen (12.58) = 100, corresponding to the formula, $CaAl_2 (F, OH)_8$, in which fluorine and hydroxyl are isomorphous.

S. L. PENFIELD.

COLOR AND ASSIMILATION.

A NEW method of measuring the effect of rays of different degrees of refrangibility upon the assimilative activity of vegetable cells has been recently devised by Th. W. Engelmann of Utrecht. It will be seen that the method is simple, and probably of wide applicability. It consists in the use of a few uninjured cells, — for instance, of some filamentous alga, — placed in water which contains bacteria. If oxygen is evolved from the cells, as in assimilation, the bacteria, which up to that time may have been quiescent, become extremely active, and the activity is greatest close to the assimilating cells. If light be now withdrawn, the supply of oxygen is soon exhausted, and the bacteria again become quiet, resuming their activity as soon as the slightest trace of free oxygen is accessible to them. By their presence it is possible to detect, according to Engelmann, the one trillionth of a milligram of oxygen.

Supposing a long filament of some alga is thus arranged under the microscope, and light passes through the slide, the character of the light is seen at once to have a very marked effect upon the movements of the bacteria. If the light has first been passed through a direct-vision spectroscope placed *under* the stage of the microscope, so that the filament lies in the length of the spectrum thus produced, the bacteria are seen to cluster immediately in certain parts of the spectrum, to the exclusion of the others; and the inference is not unfairly drawn, that they go where oxygen is most abundant. To the facts thus presented in an earlier paper, Engelmann adds, in the *Botanische zeitung* (Jan. 5 and 12, 1883), some curious observations regarding the assimilative power possessed by vegetable cells of different colors. In brief, his results are the following: only those cells which contain chlorophyll or its equivalent in the protoplasmic body have any power of evolving oxygen; a colorless cell, or one which has coloring-matter only in the cell-sap, cannot evolve oxygen under the influence of any rays of light. This has a direct bearing upon the so-called 'screen' theory of Pringsheim, according to which the pigment acts only as a screen to diminish the otherwise too intense effect of light. It may be stated that Pringsheim suggested, that, by passing through a thin layer of solution of chlorophyll-pigment, the light would be so tempered as to bring about assimilation in colorless protoplasm. Engelmann shows that this is not likely to happen under any conditions of screening.

Furthermore, in experimenting upon algae of different colors, he found that the assimilative activity is not in the same part of the spectrum for all cells. For instance: the greatest activity for red cells is in the green; for green cells, in the red; for bluish green, in the yellow; and, for yellowish brown, in the green and red; or, *in general, in the color that is almost or completely complementary to the color of the cell.* To state this in another form, it may be said that the rays of the spectrum which effect the work of assimilation are identical with those which are absorbed by the chlorophylline coloring-matter.

It may be added that a large number of Engelmann's experiments were made by the use of Edison's lamp. In *Pflüger's archiv* for Jan. 10, the same author has a paper on a bacterium which he has found to be extremely sensitive to light, and which has been named B. photometricum. There are a few points in that communication which are not wholly in harmony with the facts stated above; but, as they are of minor consequence, they may be passed over now without further mention. GEO. L. GOODALE.

LARVAL STAGES AND HABITS OF THE BEE-FLY HIRMONEURA.

NOTHING is yet known of the first larval stage of the bee-flies. I have expressed the belief that future observation would show that there is a parallel between the Meloids and the Bombyliids, in that the first or newly-hatched larva of the latter would differ from the clumsy, partially parasitic, full-grown larva,